

WHAT IS CLAIMED IS:

1. An apparatus, comprising:

an armature having at least one groove formed on an exterior surface thereof;

a sleeve, the armature being movably disposed in the sleeve; and

a spring member disposed in the at least one groove in the armature and in sliding contact with the sleeve wherein the spring member exerts a radially outwardly directed spring force against the sleeve.

2. The apparatus of claim 1 further comprising an electric coil disposed adjacent the sleeve for moving the armature in the sleeve.

3. The apparatus of claim 1 wherein the armature is generally cylindrical in shape.

4. The apparatus of claim 3 wherein the at least one groove is concentric with a longitudinal axis of the armature.

5. The apparatus of claim 4 wherein the at least one groove extends at least partially around a circumference of the armature and the spring member extends at least partially around the circumference of the armature.

6. The apparatus of claim 1 wherein the armature defines at least one hole extending axially through the armature so that fluid may flow through the armature from one side to the other.

7. The apparatus of claim 4 wherein the armature has a plurality of grooves defined therein, the grooves being concentric with the longitudinal axis of the armature, the apparatus further comprising a plurality of spring members disposed in the plurality of grooves, respectively.

8. The apparatus of claim 3 wherein the groove is formed on the armature in a helical pattern.

9. The apparatus of claim 6 wherein the armature defines a plurality of holes extending axially through the armature so that fluid may flow through the armature from one side to the other.

10. The apparatus of claim 5 wherein the groove is substantially parallel to a longitudinal axis of the armature.

5 11. The apparatus of claim 1 wherein the armature includes a valve portion extending from one end thereof.

12. The apparatus of claim 11 wherein the valve portion is formed integrally with the armature.

10 13. The apparatus of claim 11 wherein the valve portion is threaded into the armature.

14. The apparatus of claim 1 wherein the armature has a generally parallelepiped shape.

15 15. The apparatus of claim 1 wherein the sleeve comprises a plastic material.

16. The apparatus of claim 1 wherein the sleeve comprises a metal material.

17. The apparatus of claim 1 wherein the sleeve comprises a fiber-reinforced plastic material.

20 18. The apparatus of claim 1 wherein the spring member comprises a plastic material.

19. The apparatus of claim 1 wherein the spring member comprises a metal material.

25 20. The apparatus of claim 1 wherein the spring member comprises a fiber-reinforced plastic material.

21. A method of stabilizing an electromagnetically operated actuator, comprising:
providing an armature having at least one groove formed on an exterior surface thereof;
providing a sleeve wherein the armature is movably disposed in the sleeve; and
30 disposing a spring member in the at least one groove in the armature and in sliding contact with the sleeve whereby the spring member exerts a radially outwardly directed spring force against the sleeve.

22. An apparatus, comprising:

5 a sleeve having at least one groove formed on an interior surface thereof;
an armature, the armature being movably disposed in the sleeve; and
a spring member disposed in the at least one groove in the sleeve and in sliding contact
with the armature wherein the spring member exerts a friction force against the armature.

23. The apparatus of claim 22 further comprising an electric coil disposed adjacent the sleeve
for moving the armature in the sleeve.

24. The apparatus of claim 22 wherein the armature is generally cylindrical in shape.

25. The apparatus of claim 24 wherein the at least one groove is concentric with a
longitudinal axis of the sleeve.

26. The apparatus of claim 25 wherein the at least one groove extends at least partially
around an inner circumference of the sleeve and the spring member extends at least partially
around the inner circumference of the sleeve.

27. The apparatus of claim 22 wherein the armature defines at least one hole extending
axially through the armature so that fluid may flow through the armature from one side to the
other.

28. An apparatus, comprising:

an armature having at least one radial opening formed therein;
a sleeve, the armature being movably disposed in the sleeve;
a spring disposed in the at least one radial opening in the armature; and
a bearing member disposed on one end of the spring and in sliding contact
with the sleeve wherein the bearing member exerts a radially outwardly directed force against
the sleeve.

29. The apparatus of claim 28 wherein the at least one radial opening extends partially
through the armature and another end of the spring bears against a bottom of the radial
opening in the armature.

30. The apparatus of claim 28 wherein the at least one radial opening extends completely through the armature, the apparatus further comprising a second bearing member disposed on another end of the spring and in sliding contact with the sleeve wherein the second bearing member exerts a radially outwardly directed force against the sleeve.

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31. The apparatus of claim 30 further comprising a plurality of radial openings extending completely through the armature; a plurality of springs disposed in the plurality of radial openings, respectively; a plurality of bearing members, the bearing members disposed on each end of each of the plurality of springs, respectively; wherein the plurality of bearing members are in sliding contact with the sleeve and exert a radially outwardly directed force against the sleeve.

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32. An apparatus, comprising:

an armature;

a sleeve, the armature being movably disposed in the sleeve; and

a spring member in sliding contact with one of the armature and the sleeve wherein the spring member creates a friction force between the sleeve and the armature.

33. The apparatus of claim 32 wherein the armature includes at least one groove formed on an exterior surface thereof; the spring member being disposed in the at least one groove in the armature and in sliding contact with the sleeve wherein the spring member exerts a radially outwardly directed spring force against the sleeve.

34. The apparatus of claim 32 wherein the sleeve includes at least one groove formed on an interior surface thereof; the spring member being disposed in the at least one groove in the sleeve and in sliding contact with the armature wherein the spring member exerts a friction force against the armature.

35. The apparatus of claim 32 wherein the armature has at least one radial opening formed therein; the spring member comprising a spring disposed in the at least one radial opening in the armature and a bearing member disposed on one end of the spring and in sliding contact with the sleeve wherein the bearing member exerts a radially outwardly directed force against the sleeve.